High-Voltage Insulation and Transmission Technology Program

High-Voltage Engineering Program

Department of Electrical Engineering
Faculty of Engineering
Chulalongkorn University

CHULA ΣNGINEERING
Foundation toward Innovation

ELECTRICAL ENGINEERING
CHULALONGKORN UNIVERSITY

High-Voltage Technologies in Industrial and Academic Societies

High-voltage (HV) technologies play an important role in the transmission of electric power to meet the demand by industrial, residential, and other sections. The utilization of high voltages reduces losses and voltage drop in power systems. Examples of common HV equipment are transformers, (oil-filled or XLPE) cables, insulators, spacers, circuit breakers, and surge arresters.

In order to ensure the integrity of the system operation, HV apparatus must work properly under normal voltage level as well as under transient over-voltages. Therefore, it is critical that the insulation can tolerate the electric field in such circumstances. For HV power systems, insulation level of all units must be coordinated to yield the appropriate protection against lightning and switching transients.

High voltages are also related to applications such as electrostatic precipitators, material coating, plasma generation, powder processes, etc. Electromagnetic compatibility is also an important concern for electrical devices to co-exist and work properly, especially where high-voltage or high-current is involved.

Therefore, high-voltage technology is inevitably a critical infrastructure as far as electric energy is in the need of societies.

High-voltage Laboratory in Chulalongkorn University

CU High Voltage (HV) Laboratory was established in 1955 as the 1st one in Thailand. Since then, the laboratory has been active in education, research, and services. Various Equipment have been successfully built by our laboratory include high voltage kits, impulse generators, and SF6 transformers.

The HV Laboratory has been assigned responsibility by the Thai Government for electrical product tests in compliance with Thai Industrial Standards and with other standards such as IEC, ANSI, AS, etc. The test facilities are used to analyze problems of insulation in power systems and the characteristics and performances of the high voltage equipment. Problem-based services are carried out according to requests from industry.

Our Strengths :

- *Best HV facilities among universities in Thailand*
- *International collaboration for in-depth research*
- *Cooperation with agencies such as electric utilities and manufacturers for practical knowledge*

Graduate Program in High Voltage Technologies

- Design, construction, and diagnosis of HV equipment
- HV-related phenomena such as over-voltages and their usage in industry applications

Solve problems encountered in local industries and those in Thailand's research agenda.

Professional Track:

High-Voltage Insulation and Transmission Technology Program

Focus on the HV equipment usages and the linkage to industries in various aspects.

Research Orientation Track:

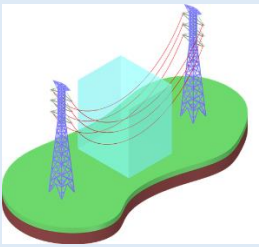
High-Voltage Engineering Program

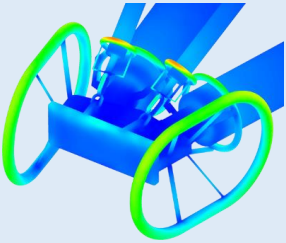
Aim to provide the study in the HV field in depth and more specific and advanced fields of research

FIELDS

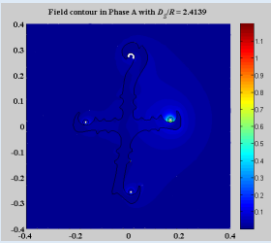
HV field simulation

***Compact Transmission Lines*:** The finite element method is applied to the numerical simulation for 230kV transmission lines. The aim is to ensure that (i) insulators and HV conductors such as corona rings are not subjected to excessively high stress, and (ii) Electric field near the ground is in the ranged recommended in an international guideline.





***Triple junction in distribution lines*:** Partial insulated cables such as SAC are often used in distribution lines. Our study shows the triple junction effect on the electric field at the interface between a cable and a spacer, which harm the insulation and lead to breakdown eventually.



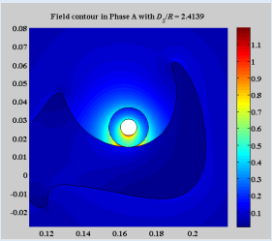


Figure: electric field on spacer (left) and triple junction (right)

FIELDS Multiple disciplines

***Manipulation of particles*:** Particles in mm and μm sizes are involved in a variety of applications such as gas insulated switchgears (GIS), electrostatic precipitator, painting, and coating. The motion of particles is controlled by their charges and the interaction with electric field. The effects of various parameters have been analyzed and experimented.

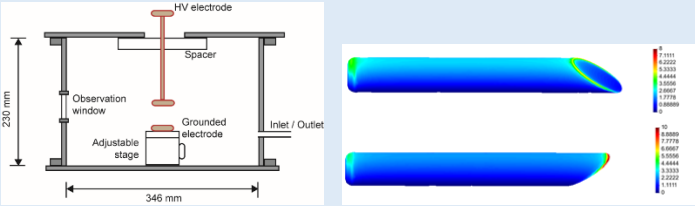


Figure: Experimental setup (left) and field analysis (right)

***Multiple-field analysis*:** Pulsed electric fields (PEF) is a non-thermal method for treating liquid foods by using electrical pulses to inactivate microbial in foods. Numerical study has been carried out to study multiple physics such as power consumption, temperature rise and microbial inactivation efficiency.

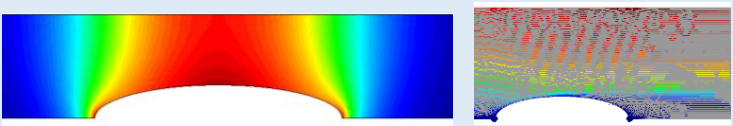


Figure: electric field distribution (left) and streamline of the liquid in a PEF treatment chamber (right)

FIELDS Power system disturbance analysis

Disturbances (e.g. surges, voltage variation, harmonics) often occur in power systems from a variety of sources and may have adverse effects on the equipment and reliability of power systems. Analysis study of abnormal phenomena and the harmful impact of resulting disturbances is an important aspect of power system operation and resilience. EMTP, DIgSLIENT PowerFactory and MATLAB are professional analysis software for a wide variety of power system studies to finding causes and solving problems encountered in the field.

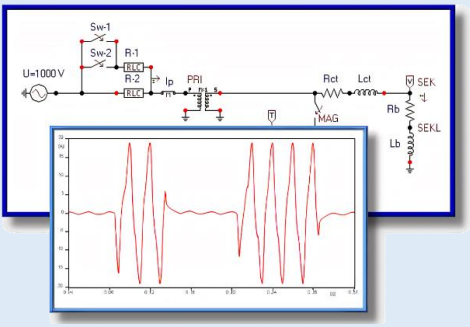


Figure: disturbance simulation in a power system

Examples of research projects:

- Ferroresonance in distribution and power transformers
- Design and impact study of capacitor banks in substations
- Effectiveness of surge arresters for lightning protection of substations

FIELDS

Condition assessment of equipment

Testing and condition monitoring of power transmission and distribution equipment are essential for preventive and predictive maintemance. Researches on the development of online monitoring techniques and asset health indices for equipment are required to quantify aging phenomena and determine incipient failure effectively.

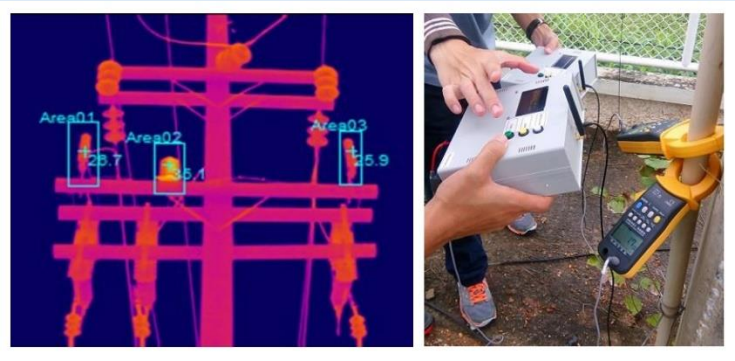


Figure: Measurements of temperature (left) and resistive leakage currents (right) of surge arresters in a distribution system

Examples of research projects:

- Design and construction of leakage current measuring systems for condition assessment of online and offline surge arresters
- Prediction of top-oil temperature in power transformers for performance assessment using machine learning models

COURSE Up-to-date and in practice

HV related courses

- Electric Field Analysis in High Voltage Engineering
- Electrical Transients in Power Systems
- Fundamentals of Electromagnetic Compatibility
- High-Voltage Equipment Maintenance and Testing
- Insulation Coordination
- Substation Automation Systems
- Other elective courses in EE curriculum

Special courses for professional track

- *Industrial Experiences* at various companies or utilities related to HV engineering
- *Internship Aboard* at universities or research institutes oversea

Other courses

- Students can take other courses in the EE graduate program for the elective credits

Teaching Faculty and Research Outlines

Prof. Boonchai Techaumnat (Dr. Eng)

Research interests include numerical electric field simulation, electrical insulation, bioelectromagnetics, and electrokinetics of particle. He received the medal prize for new scholars from the Thailand Research Fund in 2005. His research paper on the electrofusion of biological cells received the Nanobiotechnology Premium from the Institution of Engineering and Technology (IET) in 2009. He is a co-author of the book titled “Electric Fields in Composite Dielectrics and their Applications” (Springer), which received the book prize from the Institute of Electrical Engineers Japan in 2011.

Assistant Prof. Channarong Banmongkol (Dr. Eng)

Research interests include power system disturbance analysis, condition assessment of power system equipment and modern power system protection. He has experience in testing of high voltage equipment for more than 20 years and serves as the chairman and member of several academic committees of Thai industrial standards institute.

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